

DIVERSITY OF SPIDERS IN GROUNDNUT CROP FIELDS IN VILLAGE AREA OF SAURASHTRA REGION

VARSHA TRIVEDI¹

¹Department of Biosciences, Saurashtra University, Rajkot 360 005, Gujarat, India. Email: vtrivedi_2@rediffmail.com

An ecological study was carried out to determine the quantitative and qualitative community structure and population of spiders in Groundnut (*Arachis hypogaea* Linn.) crop fields. Spiders were collected at random following a quadrat method (each quadrat of 1 sq. m taken per visit, total count 25 quadrats), 25 visits every week, during the crop season from July to November, 2002, at Munjka village of Rajkot, Gujarat State. A total of 809 spiders, belonging to 37 species under 22 genera and 10 families were collected. They were classified into three guilds based on their predatory behaviour as hunting, ambushing and web building; the per cent of spiders within active groups was 68.48, 14.83, and 16.69 respectively. The largest numbers of individuals collected belonged to the families Salticidae (27.69%), Lycosidae (24.23%), Oxyopidae (11.25%), and Philodromidae (11.13%). The most abundant genera were *Marpissa*, *Pardosa*, *Oxyopes* and *Theridion*. The most abundant salticid and lycosid identified to species were *Plexippus paykulli* (Audouin) (4.94%) and *Pardosa pseudoannulata* (Bosenberg and Strand) (4.94%) respectively. Maximum density of spiders was observed during the flowering stage of the crop in September, thereafter it decreased, and evenness index (e) was almost higher (3.0) in Groundnut crop-ecosystem. The results indicated that an increased diversity index (H') was correlated with crop growth and it ranked as October - 3.94 > September - 3.89 > August - 2.73 > Nov - 0.99 > July - 0.0.

Key words: Spiders, diversity, index (H'), groundnut, crop stages

INTRODUCTION

Spiders serve as biocontrol agents (CIKS 2002). The role of spiders in the biogenesis of different agro-ecosystems has been studied by Doane and Dondale (1979). Spiders form one of the most ubiquitous groups of predaceous organisms in the animal kingdom (Riechert and Lockley 1984). They are predators of thrips, insect larvae, aphids, plant bugs, leaf hoppers, and flies as reported by Nyffeler and Benz (1980). This study reports the predatory activities, species composition, density, relative density, richness (d), evenness index (e) and species diversity (H') of the spiders in groundnut (*Arachis hypogaea* Linn.) in relation to the crop growth stages.

METHODS AND STUDY AREA

The study was carried out during July to November 2002 in a groundnut field at Munjka village, near Saurashtra University Campus, Rajkot (22° 34' N; 70° 53' E; 138 m above msl). The climate is tropical arid to semiarid with three distinct seasons: monsoon, winter and summer. Rainfall is erratic, annual rainfall during 2002 was 385 mm. Groundnut - G-4 (hybrid variety) was sown in a 7,082 sq. m area of Black cotton soil. The crop was irrigated once by river water. The *kharif* (autumn) crop is usually sown in July in Saurashtra and the vegetative phase is complete by early September. The reproductive phase lasts until mid-October and the crop is harvested during November. A single dose of insecticide was sprayed during the reproductive phase of the crop (25 mg

Parphate (Acephate 75% S.P.127 powder) and 10 ml Monocrotophos 36% S.L. mixed in 15l water).

Collections were made once a week, a total of 25 visits using the quadrat method (each quadrat of 1m × 1m per visit). Invented spiders were caught by bare handpicking (0700 to 0900 hrs; 1600 to 1800 hrs) at random and by pitfall traps (one pitfall per quadrat) completed both method under total 25 quadrats. The spiders were then preserved in 70% ethyl alcohol in plastic tubes. Identifications were done using Tikader and Malhotra (1980), Tikader and Biswas (1981), Tikader (1982), Pocock (1985), Majumder and Tikader (1991), and Gajbe (1999). Unidentified new species were considered up to genus level. Systematics was updated by Siliwal and Molur (2007).

The following formulae were used for quantitative analysis:

- Spider density = Total number of Individuals / Total number of quadrats
- Relative density = Spider density for a given month / Sum of spider densities over collection period × 100
- Familial percentage of species = (Number of species from a given family / Total number of species collected from all families) × 100

Ecological indices for qualitative analysis:

- Shannon Weiner Index (1948) of spider species diversity

$$H' \approx 3.321928/N (N \log_{10} N - \sum n_i \log_{10} n_i)$$

where, N is the total number of specimens and n_i the total number of species

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● Species richness (d) as per Margalof (1958)

$$d = (S-1) / \log N$$

where, S = total number of species for a given month,
N = number of total individuals for a given month

● Evenness index (e) as per Pielou (1966)

$$e = H' / \log S$$

where, S = total number of species for a given month,
H' = Shannon Weiner diversity index

Table 1: Distribution of Spiders by Predatory Groups in Groundnut fields

S.No.	Spider Species	Total Occurrence of Spiders					
		No. of Spiders	%	No. of Males	%	No. of Females	%
A	HUNTING GROUP	554	68.48	118	72.84	436	67.39
I	Lycosidae Sundevall, 1833	196	24.23	21	12.96	175	27.05
1	<i>Evippa pralongipes</i> (Cambridge)*	4	00.49	—	—	4	00.62
2	<i>E. rajasthanensis</i> sp. nov.*	4	00.49	2	01.24	2	00.31
3	<i>Evippa</i> sp. Simon	32	03.96	—	—	32(11 ^S , 19 ^J , 1 ^A , 1 ^S)	04.95
4	<i>Hippasa</i> sp. Simon	1	00.12	—	—	1 ^J	00.16
5	<i>Lycosa tista</i> Tikader*	22	02.72	—	—	22(2 ^S)	03.40
6	<i>L. madani</i> Pocock	5	00.62	—	—	5(1 ^S)	00.77
7	<i>Lycosa</i> sp. Latreille	19	02.35	—	—	19 ^J	02.94
8	<i>Pardosa birmanica</i> Simon*	30	03.71	—	—	30(1 ^S)	04.64
9	<i>P. pseudoannulata</i> (Bosenberg & Strand)	40	04.94	19(2 ^S)	11.73	21(2 ^S)	03.25
10	<i>Pardosa</i> sp. Koch	39	04.82	—	—	39(30 ^J , 9 ^S)	06.03
II	Clubionidae Wagner, 1887	4	00.49	—	—	4	00.62
11	<i>Clubiona</i> sp. Latreille	4	00.49	—	—	4 ^J	00.62
III	Salticidae Blackwall, 1841	224	27.69	49	30.25	175	27.05
12	<i>Marpissa bengalensis</i> Tikader	16	01.98	—	—	16	02.47
13	<i>Marpissa</i> sp. Koch	91	11.25	15 ^J	09.26	76(74 ^J , 2 ^A)	11.75
14	<i>Phidippus</i> sp. Koch	2	00.25	—	—	2 ^A	00.31
15	<i>Phlegra dhakuriensis</i> (Tikader)	17	02.10	—	—	17	02.63
16	<i>Plexippus paykulli</i> (Audouin)*	40	04.94	20	12.35	20	03.09
17	<i>Rhene</i> sp. Thorell	4	00.49	—	—	4 ^J	00.62
18	<i>Telamonia dimidiata</i> (Simon)*	14	01.73	14	08.64	—	—
19	<i>Telamonia</i> sp. Thorell	40	04.94	—	—	40(32 ^J , 8 ^S)	06.18
IV	Oxyopidae Thorell, 1870	91	11.25	30	18.52	61	09.43
20	<i>Oxyopes shweta</i> Tikader*	12	01.48	4	02.47	8	01.24
21	<i>Oxyopes</i> sp. Latreille	79	09.77	26 ^J	16.05	53 ^J	08.19
V	Miturgidae Simon, 1885	29	03.59	18	11.11	11	01.70
22	<i>Cheiracanthium poonensis</i> sp. nov.	8	00.99	8	04.94	—	—
23	<i>Cheiracanthium</i> sp. Koch	21	02.60	10 ^S	06.17	11 ^J	01.70
VI	Sparassidae Bertkau, 1872	10	01.24	—	—	10	01.55
24	<i>Heteropoda</i> sp. Latreille	8	00.99	—	—	8(6 ^J , 2 ^A)	01.24
25	<i>Olios</i> sp. Walckenaer	2	00.25	—	—	2 ^J	00.31
B	AMBUSHING GROUP	120	14.83	20	12.35	100	15.46
VII	Thomisidae Sundevall, 1833	30	03.71	—	—	30	04.64
26	<i>Thomisus pugilis</i> Stoliczka*	3	00.37	—	—	3	00.46
27	<i>T. dhakuriensis</i> Tikader	1	00.12	—	—	1	00.16
28	<i>Thomisus</i> sp. Walckenaer	26	03.21	—	—	26 ^J	04.02
VIII	Philodromidae Thorell, 1870	90	11.13	20	12.35	70	10.82
29	<i>Tibellus poonaensis</i> Tikader	2	00.25	—	—	2	00.31
30	<i>Tibellus</i> sp. Simon	20	02.47	10 ^J	06.17	10 ^J	01.55
31	<i>Thanatus dhakuriensis</i> Tikader	32	03.96	10	06.17	22	03.40
32	<i>Philodromus</i> sp. Walckenaer	36	04.45	—	—	36 ^J	05.56

Table 1: Distribution of Spiders by Predatory Groups in Groundnut fields (*contd.*)

S.No.	Spider Species	Total Occurrence of Spiders					
		No. of Spiders	%	No. of Males	%	No. of Females	%
C	WEB BUILDING GROUP	135	16.69	24	14.82	111	17.16
IX	.Theridiidae Sundevall, 1833	75	09.27	14	08.64	61	09.43
33	<i>Theridion manjithar</i> Tikader*	20	02.47	–	–	20	03.09
34	<i>Theridion</i> sp. Walckenaer	55	06.80	14(4 ^S , 10 ^J)	08.64	41(4 ^S , 37 ^J)	06.34
X	Araneidae Simon, 1895	60	07.42	10	06.17	50	07.73
35	<i>Araneus</i> sp. Clerck	1	00.12	–	–	1 ^S	00.16
36	<i>Neoscona sinhagadensis</i> Tikader	20	02.47	–	–	20	03.09
37	<i>Neoscona</i> sp. Simon	39	04.82	10 ^J	06.17	29(28 ^J , 1 ^A)	04.48
Total number of Specimens		809		162		647	
Total number of Species		37					
Total number of Genera		22					

Note: Asterisk (*) indicates common spider species reported by Patel and Pillai (1988); Non-bold alphabets and numerals in parentheses indicate specific age status for a given group of spiders; Bold numerals indicate unidentified species.

Abbreviations: A - adult; S - subadult; J - juvenile

RESULTS AND DISCUSSION

Out of 809 specimens, 37 species belonging to 22 genera and 10 families were identified (Table 1). About 57.23% of the population were juveniles, 5.56% were subadults, 34.86% were adults and 2.35% adults and subadults of unidentified new species. The spiders were classified according to their predatory behaviour following Satpathi (2004). (i) Hunting spiders with 25 species (68.48%) belonging to Lycosidae, Clubionidae, Salticidae, Oxyopidae, Miturgidae and Sparassidae; (ii) Ambushing spiders with 7 species (14.83%) of Thomisidae and Philodromidae, and (iii) Web building spiders comprising 5 species (16.69%) of Theridiidae and Araneidae. The numerically dominant family and genus rank are summarised in Table 2.

Hunting Group

(i) **Lycosidae** – is the second most dominant family in available spiders and species-wise stands on first position. Members of this group were present during all the growth stages of groundnut, represented by 10 species from 4 genera; and two unidentified species one each of genus *Evipa* and *Pardosa* (Table 1). Genus *Evipa*, *Lycosa*, and *Pardosa* were common, while *Hippasa* was found rarely. Throughout the crop season (July–November), juveniles and subadults were found in almost equal proportion to the adults. Females were more abundant than males by a ratio of 8:1 among Lycosids. Females with cocoons were found during the reproductive phase of the crop from mid-September to November. Of all spiders identified to species, *Pardosa pseudoannulata*

(Bosenberg and Strand) and *Plexippus paykulli* (Audouin) of Salticids were the most abundant, followed by *Pardosa birmanica* Simon and *Lycosa tista* Tikader respectively (Table 1). Adult females and males of *Evipa rajasthanensis* were collected only during late November.

(ii) **Clubionidae** – Clubionids (0.49%) was the tenth most abundant family caught with only juvenile females of a single species collected during the reproductive stage of the crop (mid-September to mid-October).

(iii) **Salticidae** – is one of the most dominant family represented by eight species from six genera, and two unidentified species, found during almost the entire crop season from August to October. Adult females of *Phlegra dhakuriensis* (Tikader) (2.6% of total females collected) and *Marpissa bengalensis* Tikader (2.5%) were collected in September and October, respectively; adult males of *Telamonia dimidiata* (Simon) (8.64%) were also collected in September. Other Salticid species of both sexes were found in good numbers during late August to October. Juveniles of the genera *Marpissa* and *Telamonia* were more numerous during the vegetative stage of the crop (late August to early September). During flowering and early pod forming stage of crop (mid-September to mid-October), more adult males and females were caught. During August–September fewer females than males were observed, while females dominated in October only. *Rhene* sp. was found the least (0.49% of total spiders collected); whereas *Marpissa* sp. (11.25%), *Telamonia* sp. (4.94%) and *Plexippus paykulli* (Audouin) (4.94%) were caught frequently.

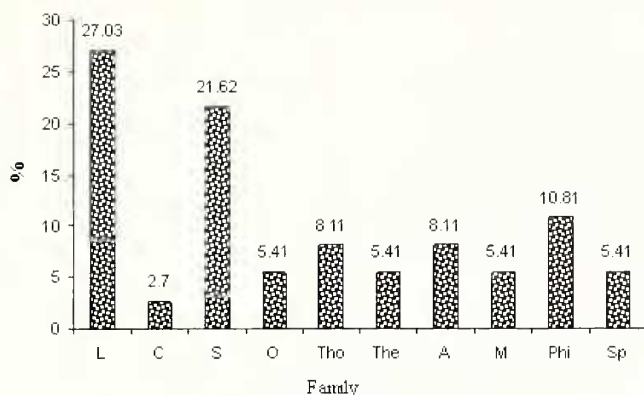


Fig. 1: Familial percentage of species

Abbreviations: L - Lycosidae, C - Clubionidae, S - Salticidae, O - Oxyopidae, Tho - Thomisidae, The - Theridiidae, A - Araneidae, M - Miturgidae, Ph - Philodromidae, Sp - Sparassidae

(iv) **Oxyopidae** – All Oxyopids were found during the late vegetative and early reproductive stage of the crop (late September-mid October). Peak abundance of adults was reached from early to mid-October. Males of *Oxyopes shweta* Tikader (2.47%) were seen on the upper parts of the plants during early October. The number of juvenile females increased considerably by late September - mid October. The number of female Oxyopids (i.e., 61/30) exceeded the number of males by a ratio of 2:1.

(v) **Miturgidae** – Members of this family have been reported to be important as pest-control agents in the agricultural sector (Sewlal and Cutler 2003). Two species of *Cheiracanthium* (3.59%) were recorded to be most abundant during the reproductive phase of the crop (late September-October). Adult males of *Cheiracanthium poonensis* (4.94%) were observed only during October. Subadult males and juvenile females of *Cheiracanthium* sp. Koch were observed from late September to October.

(vi) **Sparassidae** – These giant crab-spiders were the ninth most abundant family observed running over plants and hiding under dead leaves in only October. The adult and immature females represent 2 species, 2 genera and 2 unidentified adult spiders of *Heteropoda* sp. Latreille and juvenile females of *Olios* sp. Walckenaer, were caught in early October.

Ambushing Group

(i) **Thomisidae** – Three species of *Thomisus* (3.7%) were caught during the flowering and pod forming stage of crop during mid to late October with only female spiders. They were found moving over the terminal buds and flowers.

Thomisus is the eleventh most abundant genus (Table 2). An adult female *Thomisus dhakuriensis* Tikader was collected in late October.

(ii) **Philodromidae** – Members of this fast runner family were represented by 4 species and 3 genera. They were caught in vegetative to mid-reproductive stage of the crop (mid-August to mid-October). The female to male ratio of this family was 3.5:1. The adult and juvenile spiders of *Thanatus dhakuriensis* Tikader and *Philodromus* sp. Walckenaer respectively were most abundant (almost three times more of all philodromids) in only September. The adult male and female spiders of genus *Thanatus* were collected in August and October respectively. *Thanatus dhakuriensis* Tikader was the second most abundant spider species (Table 1).

Web Building Group

(i) **Theridiidae** – This was the fifth most abundant family, represented by 2 species of *Theridiou* (Table 1). Theridiids were observed during the late vegetative to flowering stage of the crop (September and October). The female to male ratio of this family was 4.4:1. All subadults and juveniles of *Theridion* sp. were found in October only.

(ii) **Araneidae** – This group included 3 species from 2 genera and two unidentified species of the genera *Neoscona* and *Araneus*. *Neoscona sinhagadensis* Tikader (2.47%) and *Neoscona* sp. (4.82%) were most abundant during the flowering stage of the crop (late September to October). The subadult female of *Araneus* sp. was caught in mid-October. The female to male ratio in this family is 5:1.

Table 2: Family and Genus rank in available spiders of groundnut field

Family Rank	Family	Genus	Group Rank
1	Salticidae	<i>Marpissa</i>	2
		<i>Phidippus</i>	17
		<i>Phlegra</i>	14
		<i>Plexippus</i>	8
		<i>Rhene</i>	16
		<i>Telamonia</i>	6
2	Lycosidae	<i>Evippa</i>	8
		<i>Hippasa</i>	18
		<i>Lycosa</i>	7
		<i>Pardosa</i>	1
3	Oxyopidae	<i>Oxyopes</i>	3
4	Philodromidae	<i>Tibellus</i>	13
		<i>Thanatus</i>	10
		<i>Philodromus</i>	9
5	Theridiidae	<i>Theridion</i>	4
6	Araneidae	<i>Neoscona</i>	5
		<i>Araneus</i>	18
7	Thomisidae	<i>Thomisus</i>	11
8	Miturgidae	<i>Cheiracanthium</i>	12
9	Sparassidae	<i>Heteropoda</i>	15
		<i>Olios</i>	17
10	Clubionidae	<i>Clubiona</i>	15

Table 3: Spider density, relative density, species diversity (H'), species richness (d) and evenness index (e) in relation to growth period of groundnut crop

Month	No. of quadrats	No. of individuals	No. of species	Species Density-D (no. of individuals/m ²)	Relative Density-RD (%)	Diversity Index (H')	Species Richness (d)	Evenness Index (e)
July	02	08	1	4	3.05	0	0	0
August	05	138	8	28	21.4	2.73	3.27	3.02
September	05	298	20	60	45.8	3.89	7.68	2.99
October	10	356	23	36	27.5	3.94	8.62	2.89
November	03	09	2	3	2.3	0.99	1.05	3.29
Total	25	809		131				

The status of females and males among predatory groups was analyzed (Table 1). It revealed that the percentage of female spiders (78.7%) was nearly four times higher than for males (21.3%) within all hunters. The other two groups, i.e. Ambushing (females - 83.3%) and web building (females - 82.2%), showed very close female to male ratios of about 5:1. Hunting (68.5%) spiders formed the most abundant group while the ambushing group of spiders was least numerous in the groundnut field. An analysis of age status for males and females revealed that the percentage of juveniles was 57.23% that of subadults was 5.56%, that of adults was 34.86% and that of unidentified new species was 2.35%. A high percentage of juveniles reveal that (1) ecological factors like humidity, temperature, edaphic factor, food availability etc. and their relation to physiological activities (Barghusen *et al.* 1997) of spider as food and feeding, breeding were maintained at such kind of habitat (2) predominant juveniles were of monsoon breeding families like Lycosidae, Salticidae, Clubionidae, Oxyopidae etc. (3) prolong vegetative and reproductive phase of the crop and constant irrigation provide increased insect food sources.

Assessments in relation to Crop Growth

Out of 809 specimens, a total of 8 individuals from one species of *Pardosa* sp. Koch were collected during July, 138 specimens of 8 species during August, 298 specimens of 20 species during September and 356 specimens of 23 species during October. Only 9 specimens of 2 species were collected during late November in three visits (Table 3). The catch was very poor after the crop was harvested. This data supports the results of Patel and Pillai (1988) with some similar species in the same crop. The spider density was highest during September (60 individuals /sq. m); it dropped to 36 individuals /sq. m in October. The dominant species during September included *Marpissa* sp., *Philodromus* sp., *Neoscona* sp., *Oxyopes* sp., *Lycosa tista*, and *Tibellus* sp. The relative density was therefore also highest during September (45.8%). The

species composition changed with the growth period of the crop and the species diversity (H') decreased according to the following trend: October (3.94) > September (3.89) > August (2.73) > November (0.99) > July (0.0). Spider species richness (d) followed a similar trend with the growth period of the groundnut crop as shown in Table 3. This supports the hypothesis of Pianka (1966) that as the crop growth increases the prey availability allows more species to co-exist. The evenness index of the spider species was almost high (e = 3.0) during groundnut crop growth phase. This supports the statement of Pielou (1966) that the evenly distribution of spiders increases with decreases in stress; as the most of value is higher from zero during entire crop growth phase. The familial percentage of species for the families Lycosidae (27.03%), Salticidae (21.62%), and Philodromidae (10.81%) were especially high (Fig. 1). Out of 809 spiders, 647 were females (79.98%) and 162 were males (20.02%) with a sex ratio of 4:1. Generally, the male dies after mating and the female dies in winter after laying several hundred eggs.

In similar studies, at different locations in Gujarat, dominant families observed were Theridiidae (18.96%), Lycosidae (17.90%), Salticidae (12.32%), Clubionidae (10.06%) and Thomisidae (8.51%) (Patel and Pillai 1988). Differences may be due to ecological variations like temperature, humidity, and edaphic factors. Moreover, this may reflect physiological activity of spiders. Spiders are exothermic animals both their metabolic rate and their activity levels vary with temperature and humidity as stated by Barghusen *et al.* (1997).

ACKNOWLEDGEMENTS

I thank Prof. V.C. Soni for providing laboratory facilities, and Prof. S.P. Singh, Department of Biosciences for encouragement. This work would not have succeeded without the cooperation of the groundnut field owner Mr. Nanjibhai, who allowed collecting the spiders

from his field; M.Sc. Student Hemal Kiratsata for data collection of spiders. I am thankful to Spider Expert Dr. B.H. Patel for confirmation of identified species and Dr. M.I. Patel, M.N. Science College, Visnagar, for his valuable opinions on the manuscript and to the Editor

and anonymous referee for valuable suggestions and improving the quality of this paper. Thanks are also due to University Grant Commission, New Delhi, for providing financial assistance under DSA project during the study.

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